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EXAMINER	
FITZPATRICK, ATIBA O	

ART UNIT	PAPER NUMBER
2624	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/563,957	FUNAYAMA ET AL.	
	Examiner	**Art Unit**	
	ATIBA O. FITZPATRICK	2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 October 2009*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-40* is/are pending in the application.

4a) Of the above claim(s) *11-22 and 30-40* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-10 and 23-29* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 10/29/2009 has been entered.

Response to Arguments

Applicant's arguments pertaining to the prior art rejections have been fully considered but they are not persuasive. Firstly, Applicant states that "Applicant did not previously make a "teaches away" argument". However, in the second paragraph on page 19 of Applicant's arguments received by the office on 03/31/2009, Applicant stated "In fact, Heinzmann expressly <u>teaches away</u> from claim 1, by expressly disclosing that perspective transformation should not be used, because affine transformations are allegedly superior in terms of simplicity of calculations, decreased ambiguity, and speed" (emphasis added). This statement by applicant is what prompted the office to respond by indicating the impropriety of such arguments in Final Office action dated 07/01/2009.

Applicant's amendment overcomes the 35 USC 102 rejections using the Heinzmann reference. However, the 35 USC 103 rejections are maintained. Applicant asserts that because the teachings of Heinzmann incorporate the use of affine transformations, they cannot be combined with perspective transformations. Applicant also states that such a combination would render Heinzmann unsatisfactory for its intended purpose. These statements are unsubstantiated and merely conclusory in nature. There is no reasoning or explanation provided to support these statements. That is, what prohibits the teachings of the Heinzmann reference from being combined with perspective transformations, what is the intended purpose of Heinzmann, and why would the combination render Heinzmann unsatisfactory for that intended purpose?

One of ordinary skill in the art would be quite well aware that perspective transformation can be combined with the teachings of the Heinzmann reference. Affine transformations allow for translations, rotations, scaling, and skewing where parallel lines will remain parallel after the transformation. Perspective transformations also allow for translations, rotations, scaling, and skewing, but have an additional degree of freedom such that parallel lines need not remain parallel after the transformation. Indeed, an affine transformation is merely a subset of perspective transformations with a constraint such that parallel lines must remain parallel after the transformation. Therefore, there is no reason why a perspective transformation cannot be used in applying estimates of the coordinates of the predetermined feature point instead of an affine transformation.

The intended purpose of the Heinzmann reference (for the instant claim limitations) is gaze-point estimation. There is no reason why the use of a perspective transformation (instead of an affine transformation) would cause and unsatisfactory gaze-point estimation. Note that the perspective transformation has an additional degree of freedom, such that nothing is lost by using the perspective transformation instead of the affine transformation. A perspective transformation matrix can be used to achieve the exact same result as an affine transformation. Note that a perspective transformation can be used to achieve only a single one or any combination of translations, rotations, scaling, skewing, and causing parallel lines to no longer be parallel. Also note that the Park reference has the same intended purpose of the Heinzmann reference and uses perspective transformations.

Applicant also argues that Heinzmann notes that "the required calculations [of perspective transformations] are complex and time consuming." However, Applicant takes this excerpt out of context. Heinzmann's discussion of the perspective transformation in this regard is with respect to pose estimation. Indeed, the paragraph that this excerpt is taken from (Page 144, col 1, para 5) begins: "Two different transformations may be used for <u>pose estimation</u> from monocular data: perspective or affine transformation. The perspective transformation precisely models the actual projection of a 3-D scene to the image plane. However, the required calculations are complex and time consuming and can deliver up to a fourfold ambiguity <u>in the estimate of the pose</u>" (emphasis added). Therefore, Heinzmann states that perspective transformations are complex for pose estimation, but is silent with regard to pose

estimation for eye-gaze vector estimation (as is applied to the instant claim limitations). One of ordinary skill in the art would readily see that the transformation pertaining to an entire facial pose would be more computationally intensive and complex than that of an eye-gaze estimation. The facial pose estimation involves the consideration of numerous parameters while the eye-gaze estimation involves the consideration of a single gaze point.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 1-10 and 23-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over J. Heinzmann and A. Zelinsky, "3-D facial pose and gaze point estimation using a robust real-time tracking paradigm," IEEE Int. Workshop on Automatic Face and Gesture Recognition, pp142-147, 1998) (Heinzmann) in view of Park, K. R., et al., "Gaze position detection by computing the three dimensional facial positions and motions," Pattern Recognition, Vol. 35, No. 11, Nov. 2002, pp. 2559-2569 (Park).

As per claim 1, Heinzmann teaches an image processing apparatus for estimating a motion of a predetermined feature point of a 3D object from a motion picture of the 3D

object taken by a monocular camera, comprising **(Limitations present only within the preamble are not given patentable weight)**:

observation vector extracting means for extracting projected coordinates of the predetermined feature point onto an image plane, from each of frames of the motion picture **(Heinzmann: page 142, col 2, para 2: "forwarded to the 2-D model… image plane… 2-D image positions of the features"; Fig. 1)**;

3D model initializing means for making the observation vector extracting means extract from an initial frame of the motion picture, initial projected coordinates in a model coordinate arithmetic expression for calculation of model coordinates of the predetermined feature point on the basis of a first parameter, a second parameter, and the initial projected coordinates **(Heinzmann: Fig. 1; abstract: "3-D model… initialize the feature tracking": paramaters: abstract: "feature positions… gaze direction… head rotation": Fig. 1: "feature positions… relative positions". Fig. 1 shows that the projected coordinates are extracted from the 2-D model into the 3-D model. page 142, col 2, para 2: "2-D image positions of the features are transferred to a 3-D model of the feature locations"; page 144, col 1, para 5 – col 2, para 1 : "affine transformation… a good approximation of perspective projection provided the depth of the object does not exceed 1/10 of the distance between camera and object. This is usually the case in face tracking applications.": Therefore, a parameter is the depth of object which is not expected to exceed 1/10 of the distance between the camera and the object; page 144, col 2, paras 2-3: "angle"; page 144, col 2, paras 4-5: "theta… orientations"; Fig. 3: "camera coordinates..**

angles"; Fig. 2: "angles"; page 145, col 1, para 3 – col 2, para 1: "distance and orientation"; page 145, col 2, para 2: "depth". Fig. 4: shows 9 parameters. page 146, col 1, para 3 – col 2, para 1: "Figure 4 shows the output of some tracking parameter including the rotational angles, the displacement, the gaze direction of both eyes and the uncertainty of the face tracking"); and

motion estimating means for calculating estimates of state variables including a third parameter in a motion arithmetic expression for calculation of coordinates of the predetermined feature point at a time of photography when a processed target frame of the motion picture different from the initial frame was taken, from the model coordinates, the first parameter, and the second parameter, and for outputting an output value about the motion of the predetermined feature point on the basis of the second parameter included in the estimates of the state variables **(Heinzmann: page 142, col 2, para 2: "The estimated positions of the features determine the location within the next image frame of the hardware search windows." Note that the state variables include the parameters that were listed above: page 142, col 2, para 2: "3-D triplets"; Fig. 1: "3-D pose": output)**,

wherein the model coordinate arithmetic expression is based on back projection of the monocular camera, the first parameter is a parameter independent of a local motion of a portion including the predetermined feature point, and the second parameter is a parameter dependent on the local motion of the portion including the predetermined feature point **(Heinzmann: page 142, col 2, para 2: "The 3-D model is also projected back into the image plane to adapt the constraints in the 2-D**

model."; abstract: "monocular"; page 144, col 1, para 5 – col 2, para 1 : "affine transformation… a good approximation of perspective projection provided the depth of the object does not exceed 1/10 of the distance between camera and object. This is usually the case in face tracking applications.": Therefore, a parameter is the depth of object which is not expected to exceed 1/10 of the distance between the camera and the object. This parameter is independent of local motion. Note that parameters are also listed above. page 145, col 2, para 2: "monocular"), and

wherein the motion estimating means:

calculates predicted values of the state variables at the time of photography when the processed target frame was taken, based on a state transition model **(Heinzmann: page 143, col 2, para 6: "probabilistic relocation of features based on template correlations and a simple 2-D facial model")**;

applies the initial projected coordinates, and the first parameter and the second parameter included in the predicted values of the state variables, to the model coordinate arithmetic expression to calculate estimates of the model coordinates at the time of photography **(Heinzmann: Fig. 1 and 3: Note that every frame corresponds to a time a photography)**;

applies the third parameter in the predicted values of the state variables and the estimates of the model coordinates to the motion arithmetic expression to calculate estimates of coordinates of the predetermined feature point at the time of photography **(Heinzmann: page 146, col 1, para 1-2: third parameter can be**

interpreted to be confidence Figs. 1 and 3. See arguments made above for parameters.);

applies the estimates of the coordinates of the predetermined feature point to an observation function based on an observation model of the monocular camera to calculate estimates of an observation vector of the predetermined feature point **(Heinzmann: page 146, col 1, para 1-2. Figs. 1 and 3)**;

makes the observation vector extracting means extract the projected coordinates of the predetermined feature point from the processed target frame, as the observation vector **(Heinzmann: page 145, col 1, para 3: "gaze vector"; Figs. 1 and 3; page 146, col 1, para 2: "gaze vector")**; and

filters the predicted values of the state variables by use of the extracted observation vector and the estimates of the observation vector to calculate estimates of the state variables at the time of photography **(Heinzmann: Fig. 1: "Kalman filtering". Note that every frame corresponds to a time of photography. As stated above, the state variables include the parameters. A coordinate is an observation vector originating from the origin in the corresponding coordinate space; page 145, col 1, para 3: "gaze vector"; Figs. 1 and 3; page 146, col 1, para 2: "gaze vector… Intersecting G, with a world mode1 yields the gaze point")**.

Heinzmann does not teach applies the estimates of the coordinates of the predetermined feature point to an observation function using a perspective transformation. Park teaches applies the estimates of the coordinates of the

predetermined feature point to an observation function using a perspective transformation **(Park: page 2562 – page2563: particularly page 2563, col 1, para 1: “perspective camera model”; page 2568, col 1, para 3: “perspective transformation”; Fig. 5)**.

Thus, it would have been obvious for one of ordinary skill in the art at the time the invention was made to implement the teachings of Park into Heinzmann since Heinzmann suggests a system for determining face and gaze positions using a perspective transformation in general and Park suggests the beneficial use of a system for determining face and gaze positions using a perspective transformation as to “ obtain the exact 3D positions of the initial feature points” (Park: page 2568, col 1, para 3) in the analogous art of image processing. It would have been obvious for one of ordinary skill in the art at the time the invention was made to implement the teachings of Park into Heinzmann since Heinzmann suggests the motivation “precisely models the actual projection” (Heinzmann: page 144, col 1, para 5). Therefore, both the Heinzmann and Park references highlight that the perspective transformation has the benefit of precision. Furthermore, one of ordinary skill in the art at the time the invention was made could have combined the elements as claimed by known methods and, in combination, each component functions the same as it does separately. One of ordinary skill in the art at the time the invention was made would have recognized that the results of the combination would be predictable.

As per claim 2, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein the first parameter is a static parameter to converge at a specific value, and wherein the second parameter is a dynamic parameter to vary with the motion of the portion including the predetermined feature point **(Heinzmann: See arguments made for rejection claim 1: The static parameter can be interpreted to be the length (or depth) of the gaze vector that converges to a specific gaze point (page 146, col 1, para 2).The second dynamic value is the angle or orientation that varies over time along with the motion)**.

As per claim 3, Heinzmann in view of Park teaches the image processing apparatus according to Claim 2, wherein the static parameter is a depth from the image plane to the predetermined feature point **(Heinzmann: See arguments made for rejection claim 1, 2: The depth of the feature from the image plane is considered as a parameter.)**.

As per claim 4, Heinzmann in view of Park teaches the image processing apparatus according to Claim 2, wherein the dynamic parameter is a rotation parameter for specifying a rotation motion of the portion including the predetermined feature point **(Heinzmann: See arguments made for rejection claim 1, 2: The rotation is considered as a parameter)**.

As per claim 5, Heinzmann in view of Park teaches the image processing apparatus according to Claim 4, wherein the rotation parameter is an angle made by a vector from an origin to the predetermined feature point, relative to two coordinate axes in a coordinate system whose origin is at a center of the portion including the predetermined feature point **(Heinzmann: See arguments made for rejection claim 1: page 146, col 1: "eye orientation… alpha_x, alpha_y… origin is located between the eyes")**.

As per claim 6, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein the first parameter is a rigid parameter, and wherein the second parameter is a non-rigid parameter **(Heinzmann: See arguments made for rejection claim 1, 2: The depth is the rigid parameter, and the angle/orientation is the non-rigid-parameter. Also, affine and perspective transformations are non-rigid transformation, but the depth would not be affected by the transformations)**.

As per claim 7, Heinzmann in view of Park teaches the image processing apparatus according to Claim 6, wherein the rigid parameter is a depth from the image plane to the model coordinates **(Heinzmann: See arguments made for rejection claim 1, 6.)**.

As per claim 8, Heinzmann in view of Park teaches the image processing apparatus according to Claim 6, wherein the non-rigid parameter is a change amount about a position change of the predetermined feature point due to the motion of the portion including the predetermined feature point **(Heinzmann: See arguments made for rejection claim 1, 5.)**.

As per claim 9, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein the motion model is based on rotation and translation motions of the 3D object, and wherein the third parameter is a translation parameter for specifying a translation amount of the 3D object and a rotation parameter for specifying a rotation amount of the 3D object **(Heinzmann: See arguments made for rejection claim 1, 2, and 5: Fig. 4: “Disp X… Disp Y”: translation; Fig. 1: “template tracking” Template tracking or matching accounts for in-plane translations. Fig. 3: “camera coordinates… angles”; Fig. 1)**.

As per claim 10, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein the motion estimating means applies Kalman filtering as said filtering **(Heinzmann: See arguments made for rejecting claim 1)**. Heinzmann does not teach extended Kalman filtering.

Park teaches extended Kalman filtering **(Park: page 2564, col 1, para 4: “extended Kalman”)**.

Thus, it would have been obvious for one of ordinary skill in the art at the time the invention was made to implement the teachings of Park into Heinzmann since Heinzmann suggests a system for determining face and gaze positions using Kalman filtering in general and Park suggests the beneficial use of a system for determining face and gaze positions using extended Kalman filtering as to in the analogous art of image processing. It would have been obvious for one of ordinary skill in the art at the time the invention was made to implement the teachings of Park into Heinzmann since it is well known that the extended Kalman filter is applicable to nonlinear problems whereas the Kalman filter is not. Therefore, one can apply the extended Kalman filter in order to obtain a more robust system. Furthermore, one of ordinary skill in the art at the time the invention was made could have combined the elements as claimed by known methods and, in combination, each component functions the same as it does separately. One of ordinary skill in the art at the time the invention was made would have recognized that the results of the combination would be predictable.

As per claim 23, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein a 3D structure of a center of a pupil on a facial picture is defined by a static parameter and a dynamic parameter, and wherein the a gaze is determined by estimating the static parameter and the dynamic parameter **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 9)**.

As per claim 24, Heinzmann in view of Park teaches the image processing apparatus according to Claim 23, wherein the static parameter is a depth of the pupil in a camera coordinate system **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 9)**.

As per claim 25, Heinzmann in view of Park teaches the image processing apparatus according to Claim 23, wherein the dynamic parameter is a rotation parameter of an eyeball **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 9)**.

As per claim 26, Heinzmann in view of Park teaches the image processing apparatus according to Claim 25, wherein the rotation parameter of the eyeball has two degrees of freedom to permit rotations with respect to two coordinate axes in an eyeball coordinate system **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 9: alpha_x, alpha_y)**.

As per claim 27, Heinzmann in view of Park teaches the image processing apparatus according to Claim 1, wherein a 3D structure of the 3D object on the a picture is defined by a rigid parameter and a non-rigid parameter and wherein the motion of the 3D object is determined by estimating the rigid parameter and the non-rigid parameter **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 6, 9)**.

As per claim 28, Heinzmann in view of Park teaches the image processing apparatus according to Claim 27, wherein the rigid parameter is a depth of a feature point of the 3D object in a model coordinate system **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 6, 9)**.

As per claim 29, Heinzmann in view of Park teaches the image processing apparatus according to Claim 27, wherein the non-rigid parameter is a change amount of a feature point of the 3D object in a model coordinate system **(Heinzmann: See arguments made for rejection claim 1, 2, 5, 6, 9)**.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Atiba Fitzpatrick whose telephone number is (571) 270-5255. The examiner can normally be reached on M-F 10:00am-6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on (571)272-7413. The fax phone number for Atiba Fitzpatrick is (571) 270-6255.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status

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Atiba Fitzpatrick

/A. O. F./

Examiner, Art Unit 2624

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